

Idaho Transportation Department

Solicitation #2011-02

Title

Review of Non-nuclear Density Gauges as a Possible Replacement for ITD's Current Nuclear Density Gauges

Problem Statement

ITD spends a great deal of time and money annually on nuclear density gauges. This includes training, personnel monitoring for radiation exposure, gauge repairs, calibration, and maintaining the Nuclear Regulatory Commission (NRC) license. ITD's fleet of gauges are 15 to 20 + years old, the radioactive sources are becoming depleted and the gauge electronics are failing from repeated use. The costs of maintaining this equipment in operating condition for the districts is growing more every year. In the near future all of the nuclear gauges will require replacement. ITD uses its nuclear density gauges for bound materials, i.e. Hot Mix Asphalt, (HMA), and unbound materials such as base, sub-base and soils. Some of these nuclear gauges test both bound and unbound materials, while others are specifically intended for HMA. Non-nuclear density gauges are material specific and test either bound or unbound material, depending on their design. The Department is using this opportunity to consider replacing its nuclear gauges with non-nuclear gauges to reduce operating maintenance costs and improve safety. There are a number of non-nuclear gauge options available that should be considered before deciding on replacing the old fleet of ITD nuclear density gauges.

Objectives

The objectives of this project include:

1. Evaluating commercially available non-nuclear density gauge products in terms of their capabilities/features, performance, and cost for use on bound and unbound materials.
2. Compare the performance of non-nuclear gauges to the Department's existing nuclear gauges when calibrated to known values.
3. Provide recommendations regarding the Department's replacement of nuclear gauges. The new gauge(s) will need to have results that are consistent or better in density readings when compared to the currently used nuclear density gauges.

We anticipate that approximately 75 percent of the research effort should go toward the unbound material portion of this project.

Research Proposed/Tasks

1. Perform a thorough review and evaluation of the literature on non-nuclear gauges used within the U.S. and Canada. Periodically update throughout the project to keep current with new research.
2. Provide a brief overview of theory and practices related to non-nuclear gauges specifically used for bound and unbound materials.
3. Arrange on-site demonstration of equipment operation and best practices by each gauge representative. Work with each representative to gain a working knowledge of the equipment and to become competent using the various gauges. Invite ITD to participate in training.
4. Review density test data that ITD has collected from 2005 to current using the non-nuclear HMA gauges owned by ITD.
5. Test the density of different classes of Superpave HMA, (e.g. SP2 and SP5), different nominal maximum aggregate sizes, (e.g. $\frac{3}{4}$ in. and $\frac{1}{2}$ in.), different aggregate types, (gravel and basalt); different aggregate specific gravities, (i.e. G_{sb}), and perform side by side comparisons of the non-nuclear and nuclear gauges when compared to 4 and 6 inch cores. Test under both field and laboratory conditions. Conditions that are found in the laboratory must be repeatable and/or replicated under field conditions. ITD will identify the road segments/projects to be tested.
6. Test the density of HMA at the confined and unconfined longitudinal joint. Locate longitudinal joint tests at a distance equal to the lift thickness, or a minimum of 2 inches, from each pavement edge, top of pavement. (i.e. for a 4 inch compacted lift the near edge of the density gauge or core barrel shall be four inches from the edge of pavement, top of pavement). Take density tests at both pavement edges with nuclear and non-nuclear gauges for every test performed above.
7. Test the density of a variety of unbound materials (soils and aggregates) commonly found in highway construction in Idaho by performing side by side testing with various non-nuclear density gauges and ITD nuclear gauges. Test under both field and laboratory conditions. Conditions that are found in the laboratory must be repeatable and/or replicated under field conditions. ITD will identify the road segments/projects to be tested. Interview ITD staff to identify road segments/projects to be tested. Visit representative samples of paving projects in various parts of Idaho for field testing.
8. Evaluate, review, compare and analyze non-nuclear density gauges listed below to ITD's nuclear gauges for unbound material. The Non-nuclear gauges will include but not be limited to the Humboldt GeoGauge; the Humboldt Electrical Density Gauge; the Trans Tech Soil Density Gauge, (SDG); and the Durham Geo Slope Indicator Moisture+ Density Indicator, (M+DI). Other field density measuring devices may be identified during the literature review and shall be brought to ITD's attention for possible inclusion in the study. Gauges identified must be commercially available within the United States and Canada.

9. Evaluate, review, compare and analyze the Troxler PaverTracker and the Transtech Pavement Quality Indicator (PQI) non-nuclear density gauges to ITD's nuclear gauges.
10. Data reviewed should include a summary list of the following items but should not be limited to only the following elements:
 - Equipment: review manufacture's specifications and literature, transportation issues, accuracy, precision, gauge battery voltage & life expectancy, practicability/ease of use.
 - Handling Requirements/Regulations: hazardous waste, safety issues, gauge orientation, warranty requirements, special training needs.
 - Precautions: calibration/recalibration issues, accuracy, impurities, contamination concerns, sensitivity to changes in material.
 - Technical Challenges Associated with Use (time to achieve proficiency).
 - Time Necessary to Complete Individual Tests.
 - Ability to Perform Real Time Quality Control.
 - Additional Equipment: Are nuclear gauges or other equipment required simultaneously to perform testing?
 - Accessories: Calibration block needed, etc.
11. Review and summarize significant issues that might affect the outcome of the testing and ways to compensate for such. This should include a discussion on any known interactions between the items listed and specific gauges. Discussion should include but not be limited to:
 - Effects of Pavement and Roadway Design Parameters.
 - Presence of Sand and/or Debris.
 - Presence of Paint and/or Markings.
 - Effects of Temperature (mat temperature, optimum temperature for sampling).
 - Effects of Moisture Content, (surface, internal and/or combination thereof).
 - Effects of Roller Pass.
 - Effects of Air Voids.
 - Effects of Aggregate Size (identify a minimum/maximum size if possible).
 - Effects of Sample Size (mat thickness & horizontal slab sample layout).
 - Effects of Gauge Movement.
 - Other Possible Influences and/or Combination of the Above.
12. Estimate the cost for Idaho to replace its nuclear gauges with each of the tested non-nuclear gauges and available nuclear gauges. Show demonstrated cost savings from other states or agencies. Include costs related to: equipment purchase, maintenance and operations costs as well as training costs, time savings, and labor effort. Also determine if switching gauges will allow contractors to increase the amount of density tests performed. If non-nuclear gauges are found to have a lower overall cost, include a description of the current practices and policies within the U.S. and Canada.
13. Develop a list of recommended test protocols/systems for non-nuclear systems. Discuss any industry standards for non-nuclear gauges (ASTM, AASHTO).

Deliverables

1. Comprehensive literature search, within the first 3 months, with periodic updates with each quarterly report.
2. Develop a excel database that outlines testing results for each non-nuclear gauge with corresponding nuclear gauge testing. Spreadsheets should include the following as applicable but not be limited to:
 - Contractor Information on Project.
 - Location.
 - Material.
 - Thickness.
 - Binder.
 - Percent Moisture.
 - Percent Compaction.
 - Average Moisture.
 - Wet and Dry Density.
 - Weather at Collection Time.
 - Temperature at Collection.

This should include any information on historical use within Idaho.

3. Provide an onsite demonstration of the various gauges for ITD Headquarters and district personnel at an Idaho location to be determined.
4. Write a final report describing the findings of this research along with the researcher's conclusions, cost versus benefit analyses, and recommendations.
5. Present study findings and recommendations to ITD executive staff at the conclusion of the work efforts.

ITD Project Involvement

The following will be provided by ITD:

- Historical nuclear and non-nuclear density gauge testing results from 2005 to current.
- List of projects to test.
- ITD nuclear density gauge(s) and qualified operator if needed
- Assistance in acquiring various non-nuclear density gauges for testing

Additional data will be made available upon request by the investigators.

Estimated Project Duration

12 to 18 months

Project Budget Range

\$50,000 to \$100,000

Proposal Format

All proposals must be formatted in accordance with the requirements specified in *ITD's Request for Qualifications and Interest*, which is available at:

<http://itd.idaho.gov/planning/research/proposals>.

Proposal Deadline

Proposals must be received by the close of business **November 17, 2010**. Submit proposals to:

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208-334-4432 (fax)